Investment, Duration, and Exit Strategies for Corporate and Independent Venture Capital-backed Start-ups

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Abstract

We propose a model of investment, duration, and exit strategies for start-ups backed by venture capital (VC) funds that accounts for the high level of uncertainty, the asymmetry of information between insiders and outsiders, and the discount rate. Our analysis predicts that start-ups backed by corporate VC funds remain for a longer period of time before exiting and receive larger investment amounts than those financed by independent VC funds. Although a longer duration leads to a higher likelihood of an exit through an acquisition, a larger investment increases the probability of an IPO exit. These predictions find strong empirical support.

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1 Introduction

Entrepreneurs and venture capitalists make investment decisions and choose the length of their involvement in a start-up to maximize the chances of success and the value of their ventures. They also look ahead and develop strategies to cash in on their companies. In particular, these strategies allow venture capitalists to liquidate their shares. Planning an exit strategy is as important as deciding how to start the enterprise.

There are two main exit routes for a successful start-up. The company can go through an Initial Public Offering (IPO) or can be sold to an existing firm via an acquisition.[1] Under an IPO, the venture obtains a stock market listing, which enables the company to receive additional financing for its projects and enables the insiders to eventually sell their shares to the public. If the start-up is acquired, the insiders obtain immediate cash in return for their shares.

The optimal exit route for start-ups depends on multiple factors, such as the expected profitability of the venture, the level of uncertainty, the asymmetry of information between the insiders and outsiders (e.g., potential buyers and new investors),[2] the possible conflicts of interest among insiders,[3] the financial market conditions at the time of the exit, and the characteristics of the venture capitalists. Some of these factors are affected by the partners' investment and duration decisions. Understanding the main trade-offs faced by start-ups at the exit stage is crucial because this understanding not only allows one to determine how venture capitalists and entrepreneurs divest their companies but also how the decisions are taken at the onset of the venture.

One important determinant of a start-up's investment, duration and exit route is the characteristics of the venture capital funds that are involved. Whether the start-up receives financing from Corporate Venture Capital (CVC) funds or receives financing only from Independent Venture Capital (IVC) funds is particularly important. In this paper, we explore the differences in investment, duration, and exit strategies of the start-ups depending on the nature of the venture capital funds.

Unlike traditional IVC funds, which are limited partnerships, CVC funds are private equity funds in which large corporations invest (i.e., CVC funds are subsidiaries of corporations) (Chemmanur, Loutskina, and Tian, 2011). Several differences exist between the two types of funds. First, whereas the sole objective of an IVC fund is to actualize a financial return on capital, CVC programs also care about strategic returns, such as the development of new, related business (see Sykes, 1990; Yost and Devlin, 1993; Dushnitsky and Lenox, 2006; Hellmann, Lindsey, and Puri, 2008). Second, because of the presence of the corporate parent, CVC funds can provide more industry-related knowledge and support to start-ups than IVC funds (Riyanto and Schwienbacher, 2006; Chemmanur, Loutskina, and Tian, 2011). Third, CVC managers are likely to be less concerned with immediate financial returns from their portfolio firms than IVC managers (Manso 2011;

[1] Two other exit routes that are not as commonly used are Management Buy-out and Refinancing (or secondary sales); see Schwienbacher (2009).

[2] See Cumming and MacIntosh (2003) for a discussion about the information asymmetries between sellers and the potential buyers of start-ups.

[3] See, for instance, Gompers (1995); Kaplan and Strömberg (2003); De Bettiguies (2008); and Macho-Stadler and Pérez-Castrillo (2010).

Chemmanur, Loutskina, and Tian 2011) because of several reasons. CVC investors have more unused resources, such as technology and marketing resources (Sahaym, Steensma, and Barden, 2010; Basu, Phelps, and Kotha, 2011; Da Gbadji, Gailly, and Schwienbacher, 2011). Moreover, IVC managers' payments are performance-based, whereas managers of CVC programs usually have fixed salaries and receive corporate bonuses. Finally, the IVC managers' abilities to raise additional funds depend on their reputations, which are influenced by their history of success (Gompers, 1996; Dushnitsky and Shapira, 2010). As a result of these differences, IVC fund managers are more concerned about quick exits than CVC fund managers.

We focus on the fact that CVC funds are more patient than IVC funds in realizing financial returns from their investments in start-ups, and we analyze how this difference influences the strategies of the start-ups. We propose a simple model that accounts for the high level of uncertainty regarding the returns from an investment in a start-up, the existence of private information in the hands of insiders, and the discount rates of the partners in the start-ups. We choose to study a rather parsimonious model in which we abstract from possible internal conflicts among insiders and some of the dynamic interactions between investment and duration. Our objective is to build a model that encompasses three crucial decisions in the lives of start-ups (investment, duration, and exit) rather than focusing on other, albeit interesting, aspects that appear at particular moments in time. This modeling strategy allows us to obtain theoretical results concerning the aforementioned decisions, which we test using data from U.S. start-ups. Our empirical results confirm the theoretical predictions.

In our model, the amount of capital invested in a start-up influences the start-up's expected value. We assume that a higher investment leads to a more favorable distribution of the set of potential values. Furthermore, the decision regarding the duration of the start-up (i.e., the length of the relationship between the entrepreneur and the VCs until the exit of the start-up), affects the market information about the probability of the venture's success. We assume that the potential value of the venture at the time of its exit will be known to every market participant. Nevertheless, insiders have more precise information about the expected profitability of a start-up because they know the probability of its success. Whether outsiders are informed of this probability depends on how long the start-up remains in the market before exiting.

We show that the ventures with a higher probability of success are more likely to attempt an IPO, whereas those with lower probabilities prefer to seek an acquirer. Moreover, the likelihood of exiting through an IPO increases with the potential value of the start-up as long as that value is positive. In contrast, start-ups with negative potential value are liquidated.

We link a start-up's exit strategy with the investment decision and with the market level of information. We show that a higher investment level induces a greater likelihood of a successful exit. Of the successful exits, the higher the investment level is, the higher the likelihood of an IPO exit. Moreover, the IPO exit rate is lower if outsiders receive more precise information, that is, if the duration of the venture is longer. Finally, we analyze the optimal investment and duration decisions of the start-up. In particular, we show that both the level of investment and the duration of the venture decrease with the discount rate of the venture capital.

The theoretical and empirical academic research on venture capital is growing. There are plenty of studies on the effect of VC funds (v.s. non-VC funds) on the exit strategy of the start-ups. However, the impact of the type of VC funds (i.e., CVC funds v.s. IVC funds) on the investment, on the exit and, in particular, on the duration strategy of start-ups has not received much attention in the previous literature.[4] We discuss briefly the contributions that are most relevant to our paper.

With regard to the influence of VC fund characteristics on the level of investment for a start-up, the theoretical model of Hellmann (2002) and the empirical analyses of Gompers and Lerner (2000) and Masulis and Nahata (2009) also find that start-ups receive higher investment amounts from CVC funds than from IVC funds. Concerning the choice of an exit route (i.e., IPO vs. acquisition), most papers suggest that because of the CVC funds' strategic returns, CVC-backed start-ups are more likely to exit through an acquisition than IVC-backed start-ups. This argument has been put forward by theoretical studies (Hellmann, 2002; Riyanto and Schwienbacher, 2006) and has received empirical support from a study using a European dataset (Cumming, 2008). Based on survey evidence, Siegel, Siegel, and MacMillan (1988) and Sykes (1990) also find that the percentage of acquired CVC-backed start-ups is higher than the percentage of acquired IVC-backed ventures. However, this result is challenged by Gompers and Lerner (2000) and Chemmanur and Loutskina (2008), who find that CVC-backed start-ups exit more frequently through the IPO market than IVC-backed start-ups do. Moreover, few start-ups appear to be acquired by the parent companies of the CVC funds that financed these ventures. In the ThomsonOne and the Securities Data Company Global New Issues databases that we use, only 5% of the start-ups with CVC financing that exit via acquisitions are bought by the parent company of the CVC fund. Maula and Murrey (2001) find a similar result. Our paper introduces the duration strategy as an important determinant of the exit choice. In this way, we provide an explanation for the disagreement in the empirical results regarding the exit choices made by CVC- and IVC-backed start-ups.

2 The Model

We propose a model to analyze the optimal investment and duration decisions, as well as exit strategy of a start-up (S). As mentioned in the Introduction, we abstract from possible internal conflicts among venture capitalists and managers/founders of the start-up. Therefore, the decisions made by the start-up at any stage aim to maximize its expected discounted profits, that is, expected income minus costs (including investment costs).[5]

In our model, the start-up takes decisions at two moments. First, it decides on the level and the length of the investment. While we acknowledge that the financing of a start-up is a dynamic process where, at each period, the information on the current development of the start-up is used to decide about the next investments, we simplify this process and assume that the total investment

[4]See Da Rin, Hellmann, and Puri, forthcoming, for a survey of the academic work on venture capital and, in particular, for a review of the papers that examine the structures and strategies of VC funds.

[5]In Section 6, we discuss the implications of the nature of the VC on the objective function of the start-up.

amount and the duration are fully determined at the beginning of the model.[6] Second, the start-up decides the exit route. This decision is made once some uncertainty about the profitability of the venture is resolved and the new information is known by the start-up and, possibly, also by outside agents.

We now formally describe the model, that is, the sequence of events and the consequences of the start-up's decisions. Figure 1 captures the time line. The model is as follows:

At $t = 1$, the start-up selects the level of investment I and the duration d. The level of investment has a positive impact on the expected quality of the venture, whereas the duration influences the amount of information that flows to the acquisition market. More precisely:

- The value of I determines the distribution of the potential value of the start-up V. We denote by V the potential net value of the venture, that is, the revenues that the start-up can generate, once we subtract the additional expenses required to continue with the firm. The variable V can be positive or negative. We assume that investment I shifts the distribution of V to the right: higher investment leads to higher expected revenues (by allowing to hire more qualified managers and workers, to buy better equipment, to conduct more in-depth market studies, etc.). For the sake of simplicity, we assume that ex ante V is uniformly distributed over the interval $[f(I), \widehat{V} + f(I)]$, where $f(I)$ is an increasing function of I.

- The level of d influences the information accessed by potential acquirers about the probability p of success (i.e., the probability of realizing V). We assume that p is uniformly distributed ex ante over the interval $[0, 1]$.

After the start-up has invested and before the exit decision, the uncertainty concerning V and p is resolved (that is, "Nature" chooses V and p). Both the start-up and the outside market can observe the realization of the value of V. The start-up also learns p. However, the potential acquirers only learn p with probability $h(d)$, which increases as the duration d increases. Therefore, while insiders and outsiders get information about the expected value of the project pV, the insiders may retain some private information about it.[7]

At $t = 2$, the start-up makes the exit decision. It has three possible exit routes: liquidation, an acquisition, or an IPO.

- The liquidation value of the start-up is always 0.

[6] Therefore, our model does not account for some dynamic aspects of the start-up that are not relevant for our purposes. Additionally, with stage financing, the uncertainty is somewhat but not completely mitigated. The simplified one-period model that we use to describe the investment and duration decisions is just one extreme case in which more uncertainty exists at the time when decisions are made. It allows the consideration of investment, duration and exiting decisions in a simple two-period model.

[7] In our model, all of the market participants can observe some of the information, but the insiders acquire more precise information on the expected quality of the project than the outsiders do. The expression of the expected value of the project pV in two terms is an easy way to model the partial acquisition of information by everyone and, simultaneously, the eventual existence of asymmetric information. We reflect the information asymmetry between insiders and outsiders through the parameter p. We could also assume that the potential asymmetric information concerns the parameter V instead of p without affecting the results of the paper.

- The deal price that the start-up obtains if it decides to seek an acquirer is the issue of a negotiation between the two parties. Therefore, it depends on their respective bargaining power and on the information obtained by the acquirer. We assume that, in the Nash bargaining, the start-up obtains a share m of the venture's expected value from the acquirer. That is, for simplicity, we consider that the profits of the outside option for both start-up and acquirer are 0 and that the bargaining power of the start-up is m (and that of the acquirer is $1 - m$).[8]

- The valuation of the start-up in an IPO depends on the result of a thorough analysis concerning all possible aspects of the start-up. An IPO is a process that requires underwriters, attorneys, accountants, financial printers, and financial analysts. They exercise due diligence in aspects such as corporate valuation, customers' assessment and market prospects, as well as on legal, financial and Intellectual Property matters. We use $F > 0$ to denote the substantial out-of-pocket expense that is involved in preparing an IPO. The process generates a public signal about the profitability of the venture that we denote by $\widetilde{\beta}$, $\widetilde{\beta} \in \{H, L\}$. We assume a very simple structure for the signal: a realization of $\widetilde{\beta} = H$ represents a situation where the process has been able to verify that the start-up will be a success whereas $\widetilde{\beta} = L$ represents a situation where the IPO process has not been able to make the verification. The probability of observing $\widetilde{\beta} = H$ depends on the actual probability of success p and we assume that it is equal to βp, with $\beta > 0$. If the realization of the signal is H, the competitive market sets a price Z for the IPO that is equal to the start-up's expected value. If the start-up accepts the price, then a successful IPO is executed. If the signal is L, no offer is issued.[9]

We make assumptions regarding the functions $f(I)$ and $h(d)$ to ensure that the three exit routes are possible. We assume that $\widehat{V} + f(0) > F/(\beta - m)$ and that $f(I)$ is concave enough (specifically, $\lim_{I \longrightarrow \infty} f(I) \leq 0$). Also, the screening is informative enough: $\beta > m$. Finally, the venture makes interior choices of I and d if $\lim_{I \longrightarrow 0} f'(0) = \lim_{d \longrightarrow 0} h'(0) = \infty$ and $h(d)$ is concave enough.[10]

We solve the model through backward induction, realizing that asymmetric information may exist among the participants. Therefore, we use sequential equilibrium as the solution concept because it combines subgame perfection ideas with Bayesian updating.

[8]The outside option for both agents is typically not zero. In reality, if the negotiation between the start-up and the (potential) acquirer would fail, the start-up could seek another buyer and the previous potential acquirer could invest the resources in another venture. The assumption that the outside option gives zero profits to both participants is made for simplicity. The relevant hypothesis is that both agents obtain a share of the surplus.

[9]We assume that a start-up that receives a low signal does not receive any offers. We make this assumption for the sake of simplicity. For those start-ups that receive a signal L, the situation is often similar to the market for lemons in Akerlof (1970)'s model; that is, taking into account the set of start-ups that accept the offer, there is no price under which market profits are non-negative (for an analysis, see Guo, 2010).

[10]If $\beta < m$, then the IPO route is never chosen. If $\hat{V} + f(0) < F/(\beta - m)$, then those start-ups with low investment levels never take certain exit routes. If $\lim_{I \longrightarrow \infty} f(I) > 0$, then those start-ups with high investment levels never undergo liquidation. However, our qualitative results would remain the same, despite the changes in the hypotheses. Similarly, if $\lim_{I \longrightarrow 0} f'(0) = \lim_{d \longrightarrow 0} h'(0) < \infty$, then the optimal decision concerning I and/or d may be the corner solution $I = 0$ and/or $d = 0$, which would complicate the analysis without adding new insights.

3 The Analysis of the Optimal Exit Strategy

In this section, we start at $t = 2$. At this stage, the potential value of the venture V is realized and observed by all of the participants. Moreover, the start-up has received a private signal concerning the probability of success p. The potential acquirer may or may not have this information p (this information is accessed with probability $h(d)$). We study the optimal exit strategy in both situations.

3.1 Optimal Exit Strategy with Informed Acquirers

It follows immediately from the description of the three exit routes that the firm is liquidated if $V \leq 0$, in which case the value of the start-up is 0.[11] We now compare the start-up's expected profits under the other two exit strategies when $V > 0$ and the probability of success is p.

If the start-up negotiates with an acquirer that knows p, the expected value of the start-up is pV and the bargaining between start-up and acquirer will produce a deal price of mpV.[12] If the start-up goes through an IPO, it pays F and receives a valuation that depends on the realization of the signal $\widetilde{\beta}$. If $\widetilde{\beta} = L$, which happens with a probability of $(1 - \beta p)$, the start-up does not receive any offer. If the realization is $\widetilde{\beta} = H$, then the competitive investors' market offers $Z = V$, which the start-up accepts.

Therefore, the start-up obtains higher expected profits by issuing an IPO rather than negotiating with an acquirer if and only if

$$\beta pV - F \geq mpV. \tag{1}$$

Proposition 1, whose proof follows the previous discussion, describes the optimal exit strategy in this case.

Proposition 1. *Consider a start-up characterized by (V, p) in a situation where the potential acquirers have learned p. The start-up's optimal exit strategy is as follows:*

1. *If $pV \leq 0$, the start-up is liquidated and realizes the payoff $U_o(V, p) = 0$.*
2. *If $pV \in (0, F/(\beta - m))$, the start-up goes to the acquisition market. It obtains a deal value $U_o(V, p) = mpV$.*
3. *If $pV \geq F/(\beta - m)$, the start-up invests F and goes to the IPO market. Moreover,*
   - *(a) If the public signal is H, then the start-up receives an offer $Z = V$ from the IPO market and accepts it;*
   - *(b) If the public signal is L, then the start-up does not receive any offer from the IPO market.*

[11] We use the convention that a start-up that is indifferent between being liquidated or not chooses liquidation. Similarly, a start-up that is indifferent between going to an IPO and looking for an acquirer at $t = 2$ goes to an IPO.

[12] See, for instance, Osborne and Rubinstein (1990) and Muthoo (2002) for bargaining protocols that lead to this payoff for the "seller", that is, for the start-up.

Therefore, in this case, the start-up's expected payoff is $U_o(V,p) = \beta pV - F$.

The basic trade-off between an IPO and an acquisition is that, although the IPO process is costly, it also allows the owners of profitable ventures that receive a high signal to realize a larger share of the ventures' value. Start-ups with a sufficiently high probability of success are ready to pay the cost of the process.

We notice that the higher the potential value V, the more willing the start-up is to go to the IPO market. Moreover, an efficient IPO process, reflected by a low cost F and a powerful screening capability β, an inexpensive IPO process, and a higher bargaining power m increase the attractiveness of an IPO exit.

3.2 Optimal Exit Strategy with Uninformed Acquirers

If the potential acquirer does not know the value of p, the optimal strategy of a start-up searching for an exit can only be analyzed by finding the Bayesian Nash equilibrium of a game where one of the parties (the start-up) has private information relevant to the relationship (the probability of success).

In this situation, as before, the start-up is liquidated if and only if $V \leq 0$. Concerning the start-ups with $V > 0$, one subset of "types" p seeks for an acquirer whereas the complementary subset issues an IPO. For an start-up going to an IPO, on the one hand, the IPO offer is $Z = V$ if the signal is $\widetilde{\beta} = H$, and the start-up accepts the offer. On the other hand, there will be no offer if the signal is $\widetilde{\beta} = L$.

We now analyze the bargaining situation between a start-up (whose type belongs to the subset of types that seek for an acquirer) and the acquirer. The latter can not observe the type of the start-up. Additionally, from the point of view of the negotiation, all the types are indistinguishable (there is no room for signaling, as the cost of the signal would be the same for every possible type). Therefore, the negotiation between the acquirer and the start-up is similar to another one where the acquirer faces one start-up whose (known) value corresponds to the expected value of the subset of types that, at equilibrium, seek an acquirer. And the deal price will be the share m of that expected value.[13]

Given that the equilibrium deal price does not depend on the actual probability p of the start-up, the difference between potential profits from an IPO and those from an acquisition increases with the value of pV. Therefore, there is a cut-off equilibrium value $p^*(V)$ such that the start-up goes to an IPO if $p \geq p^*(V)$ whereas it seeks an acquirer if $p < p^*(V)$. Given the start-up equilibrium behavior, the expected value of pV of the start-ups that seek an acquirer is $p^*(V)V/2$ and the deal price is $mp^*(V)V/2$.

[13] To be more precise, denote W the expected net value of the subset of start-ups that, at equilibrium, go the acquisition market. Consider a bargaining protocol (a game of alternating offers) between an acquirer and a start-up whose probability is known by the acquirer and whose net value is W. Suppose that the subgame perfect equilibrium strategies in the bargaining protocol lead to a deal price of mW (this may happen as the time between offers converges to zero, see Osborne and Rubinstein, 1990, and Muthoo, 2002). Then, the same strategies constitute a subgame perfect equilibrium in the game between an acquirer and a start-up whose probability p is unknown to the acquirer and whose expected net value is W. In this equilibrium, the start-up follows the same strategy independently of its "type".

A start-up with potential value V and whose probability of success is equal to $p^*(V)$ must be indifferent with regard to whether it goes to an IPO or looks for an acquirer. Therefore, $p^*(V)$ is characterized by

$$\beta p^*(V)V - F = mp^*(V)V/2 \tag{2}$$

when the solution to the equation is lower than 1 and $p^*(V) = 1$ otherwise. Proposition 2 describes the equilibrium behavior of start-ups in a situation where outsiders do not know the value of p.

Proposition 2. *Consider a start-up characterized by (V, p) in a situation where the potential acquirers do not know the value of p. The start-up's equilibrium exit strategy is as follows:*

1. *If $pV \leq 0$, the start-up is liquidated. It realizes the payoff $U_{oo}(V, p) = 0$.*
2. *If $pV \in (0, F/(\beta - m/2))$, the start-up goes to the acquisition market. It obtains a deal value $U_{oo}(V, p) = \frac{1}{2}mV$ if $V \leq F/(\beta - m/2)$ and $U_{oo}(V, p) = mF/[2(\beta - m/2)]$ if $V > F/(\beta - m/2)$.*
3. *If $pV \geq F/(\beta - m/2)$, the start-up invests F and goes to the IPO market. Moreover,*
   - *(a) If the public signal is H, then the start-up receives an offer $Z = V$ from the IPO market and accepts it;*
   - *(b) If the public signal is L, then the start-up does not receive any offer from the IPO market.*

   Therefore, in this case, $U_{oo}(V, p) = \beta pV - F$.

4 The Impact of Investment and Duration on the Likelihood of an IPO and on the Rate of Success

We now analyze how a start-up's optimal exit strategy is influenced by its investment and duration decisions.

A higher investment level implies a shift in the distribution of V toward higher values. As shown in Propositions 1 and 2 (see also Figure 2), the higher the value V is, the more likely the exit is to occur through an IPO rather than through an acquisition, regardless of whether the potential acquirers know the value of p. Therefore, a higher investment level should imply a higher IPO rate among successful cases. Proposition 3 presents this result.

Proposition 3. *The likelihood of an IPO among successful exits increases with the investment I.*

Moreover, a larger investment implies a shift in the distribution of V toward higher values, which should also lead to a greater likelihood of a successful exit. Proposition 4 states this result, whose proof is immediate.

Proposition 4. *The rate of successful exits increases as the investment I increases.*

A longer duration indicates that the market has more precise information about the probability of the start-up. In our model, this increased availability of information is reflected by a higher likelihood that the acquisition market knows the probability of success p. The next proposition investigates whether an IPO exit is more likely with informed or uninformed acquirers. The proof of the proposition is derived from Equations (1) and (2).

Proposition 5. *The probability of issuing an IPO is higher if the potential acquirers have not learned the value of p than if they have learned the value of p.*

Figure 2 explains Proposition 5 and depicts the optimal exit strategy highlighted in Propositions 1 and 2. For high-value start-ups, that is, for high levels of pV, an IPO is the optimal exit route, regardless of the information known by the potential acquirers. Similarly, going to the acquisition market is always the optimal start-up strategy for low, but positive values of pV. In the intermediate (shadow) region of Figure 2, start-ups turn to an IPO if the outsiders have not learned the value of p. However, start-ups prefer going to the acquisition market if outsiders do know the value of p.

The intuition for the existence of the intermediate region in Figure B is as follows. When it chooses the best exit, a start-up trades-off the possibility of a high IPO valuation, at a cost, versus the deal price obtained from an acquirer. Both the IPO valuation and the IPO cost are independent of the acquirer's information, but the deal price is not. If the acquirer observes the true value of p, the deal depends on pV. However, if it does not observe the true probability of success, the deal depends on the expected value of the start-up, which is independent of the true value of p. Hence, the deal is a relatively good one for low-valued start-ups whereas it is a relatively bad one for high-value start-ups. A start-up that is indifferent between the two exit routs when information about p is public (a high-value start-up) is strictly better-off issuing an IPO if the acquirer does not know p. The same holds for start-ups whose value is somewhat lower. As a consequence, an uninformed acquisition market is more likely to promote IPO exits.

Longer durations cause more information about p to become available to outsiders. According to Proposition 5, this relationship implies, ceteris paribus, a reduction in the likelihood of an IPO exit. We state this argument in the following corollary:

Corollary 1. *The likelihood of an IPO among successful exits decreases as the duration d increases.*

We note that, according to our model, the duration has no effect on the level of V. Therefore, the rate of successful exits is not influenced by the duration d.

5 Investment and Duration Decisions

In this section, we address the optimal initial decisions made by the start-up at $t = 1$. The analysis presented in Section 3 allows us to compute the expected income $U_o(V, p)$ or $U_{oo}(V, p)$ of a start-up whose potential, publicly known value is V and whose probability of success is p, depending on the degree of information known by the outsiders. We now calculate the expected profits for a given duration d and a given investment I, which is denoted as $U(d, I)$. Performing the calculation requires us to take the expectation of the expected income over the possible values of V (whose distribution function $\Gamma(V; I)$ depends on I and p):

$$\begin{aligned} U(d, I) &= e^{-rd} \int_V \int_p \left[h(d)U_o(V, p) + [1 - h(d)]\, U_{oo}(V, p)\right] dpd\Gamma(V; I) - I \\ &= e^{-rd} \left[h(d)EU_o(I) + (1 - h(d))EU_{oo}(I)\right] - I \end{aligned} \tag{3}$$

where we denote

$$EU_o(I) = \int_V \int_p U_o(V, p)dpd\Gamma(V; I), \tag{4}$$

$$EU_{oo}(I) = \int_V \int_p U_{oo}(V, p)dpd\Gamma(V; I). \tag{5}$$

We can interpret $EU_o(I)$ as the expected profits at the exit time of a start-up that has invested I at $t = 0$ and whose realized probability p is always known by its potential acquirers. Similarly, $EU_{oo}(I)$ is the start-up's expected profits if the realization value of p is unknown to outsiders. $h(d)$, the probability that the information is known by the potential acquirers, increases with the duration. Moreover, the longer the duration d is, the lower the expected profits at $t = 0$ because of discounting.

Lemma 1 shows that $EU_o(I)$ is always higher than $EU_{oo}(I)$. That is, the start-up's expected profits are higher when the potential acquirers learn p than when they do not. While interesting by itself, this result is particularly useful in the analysis of the optimal duration and the investment decisions.

Lemma 1. *$EU_o(I) > EU_{oo}(I)$ for every $I > 0$.*

The asymmetry of information between start-ups and potential acquirers makes it more profitable for some ventures (i.e., those whose probability of success lies in the interval $(p^*(V), p(V))$) to go to the IPO market, though they would obtain a better deal in the acquisition market if the information were symmetric. Therefore, in expectation, the start-up's profits are higher if information about p reaches the potential acquirers (i.e., $EU_o(I) \geq EU_{oo}(I)$).

The optimal duration and investment decisions (d^*, I^*) are interior. Therefore, they satisfy the first-order conditions $\frac{\partial U}{\partial d}(d^*, I^*) = \frac{\partial U}{\partial I}(d^*, I^*) = 0$. In Proposition 6, we examine the effect of the discount rate r on (d^*, I^*).

Proposition 6. *The optimal duration d^* and investment I^* decrease as the discount rate r increases.*

Proposition 6 is intuitive. Keeping the level of investment constant, a longer duration means higher income because of the better information by the acquirers (see Lemma 1) but at a latter moment. Therefore, the optimal duration and the discount rate should go in opposite directions. Similarly, keeping the duration constant, the optimal investment level should decrease with the cost of the money, hence with the interest rate. Therefore, if the start-up cares less about the future, it invest less in the venture and for a shorter period of time.

The proposition also allows us to discuss the (indirect) effect of r on the likelihood of an IPO exit. A lower interest rate r implies both a higher investment level and a longer duration, which, according to Proposition 3 and Corollary 1, have opposite impacts on the likelihood of an IPO exit. On the one hand, a larger investment leads to more exits through IPOs. On the other hand, a longer duration implies a better-informed potential acquirer, which leads to more acquisitions.

6 CVC- versus IVC-backed Start-ups: Empirical Implications from the Theoretical Model

The analysis presented in the previous sections highlights the indirect effects of the discount rate on the likelihood of the different exit routes. In this section, we link these results with the discussion on the differences between the start-ups that receive investments from CVC funds and the start-ups that receive only IVC funding.

Decisions on a start-up depend on the objectives of managers, founders, and investors. As we have already mentioned, we abstract in this paper from the conflicts of interest that may arise because of differences in objectives among managers/founders on one side and investors on the other side. If we focus on the "discount rate" that the start-up uses to take its decisions, the main factor of influence is the discount rate applied by the investors. Then, we argue that a start-up that receives CVC financing uses a lower discount rate than a start-up that receives only IVC financing because, as discussed in the Introduction, CVC funds are typically less compelled to recover their investments early in the process (Manso, 2011; Chemmanur, Loutskina, and Tian, 2011).

Based on the previous discussions, we associate a lower discount rate to the start-ups that receive CVC funding. We use our theoretical results to propose empirical hypotheses concerning the differences between CVC- and IVC-backed start-ups with respect to investment amounts, duration before exits, exit strategies, and success rates.

First, Proposition 6 shows that the start-ups with lower discount rates choose higher investment levels. Therefore, we should observe higher investments in CVC-backed start-ups than in IVC-backed start-ups. We state this empirical implication in the following hypothesis.

Hypothesis 1. *CVC-backed start-ups receive higher investment amounts than IVC-backed start-ups.*

Second, Proposition 6 also implies that CVC-backed start-ups (having lower discount rates) choose to stay longer before they exit. This argument is reflected in Hypothesis 2.

Hypothesis 2. *CVC-backed start-ups have longer durations than IVC-backed start-ups.*

Third, our theoretical model shows that the characteristics of VC funds *indirectly* impact the exit strategies of start-ups. As previously mentioned, CVC-backed start-ups invest more in their projects than those backed by IVC financing. The model predicts that a higher investment level increases the probability of an IPO exit (see Proposition 3). Furthermore, a start-up with CVC backing also stays longer and is less likely to exit via an IPO, according to Corollary 1. Our model states that once we account for the effects of investment and duration, the characteristics of the VC funds do not play a role in the choice of the exit strategy. We test the previous theoretical results using Hypothesis 3.

Hypothesis 3a. *The investment amount has a positive effect on the probability of an IPO exit.*

Hypothesis 3b. *The duration of a start-up before it exits has a negative effect on the probability of an IPO exit.*

Hypothesis 3c. *CVC-backed start-ups have the same probability of undergoing an IPO exit as IVC-backed start-ups once investment and duration are controlled for.*

Fourth, higher investments imply higher rates of successful exits (see Proposition 4), whereas the duration of start-ups and the characteristics of funds do not have any direct effect on the rate of successful exits. Hypothesis 4 states these implications from our theoretical model.

Hypothesis 4a. *The investment amount has a positive effect on the probability of a successful exit.*

Hypothesis 4b. *The duration of a start-up before it exits has no effect on the probability of a successful exit.*

Hypothesis 4c. *CVC-backed start-ups have the same probability of a successful exit as IVC-backed start-ups once investment and duration are controlled for.*

7 Data and Measures

We obtain the venture capital data from the ThomsonOne private equity database. This database contains detailed information regarding the characteristics of U.S. start-ups and their venture capital investors, such as exit routes (IPO vs. acquisition), exit dates, type of venture capital funds (CVC vs. IVC), investment amount, and fund size, etc. To make sure that we get correct exit information, we obtain the list of IPO exits and acquisition exits from the Securities Data Company (SDC) Global New Issues Database. We then merge the IPO list and the acquisition list from SDC with the exit information from ThomsonOne.[14] We only keep the start-ups that have exit information (IPO or acquisition) in both databases. If a start-up has different exit information (i.e., different IPO date, different effective date or different IPO price, etc) from the two databases, we use the information from SDC New Issues Database. We also gather information from Compustat for financial data and Morgan Stanley Capital International (MSCI) for the stock market information.

After merging the four data resources, we obtain our final sample, which consists of 4,506 successful U.S. start-ups with first investment year from 1980 to 2008.[15] The final sample is a cross-sectional data at start-up level. [16]

[14] We merge these two databases because of some authors' concern about the accuracy of the exit information in ThomsonOne (see, for instance, Da Rin, Hellman, and Puri, forthcoming). We also run all the regressions in this paper only with the exit information from ThomsonOne, and the results are very similar.

[15] Our theoretical model predicts that CVC-backed start-ups have higher investment levels and stay longer before exiting. This model considers both successful exits (IPOs and acquisitions) and unsuccessful exits (liquidation). However, we obtain the same results when we only consider the successful exits in the theoretical model. In the later sections, we use an enlarged dataset (with both successful and unsuccessful start-ups) to test Hypothesis 4, though the dataset is poor in quality because of the information restriction of ThomsonOne. Therefore, we test our main theoretical predictions (Hypotheses 1 to 3) only based on the successful start-ups.

[16] We run all the regressions using start-up level data in the paper to match with the theoretical analyses in the previous sections. It is a cross-sectional data instead of panel data because each start-up has one IPO date or

The main independent variable of interest assesses whether a start-up receives financing from CVC funds. To define whether a VC fund is CVC or IVC, we start from the information of the type of investors provided by ThomsonOne database. Using the definition from ThomsonOne, we have 554 CVC firms in our merged sample. Then we manually identify the parent corporations of CVC firms and the industry classification (SIC code) of those parent corporations. Because CVCs are subsidiaries invested by non financial corporations, we manually identify the investors of CVC funds based on different information source (such as Google, Lexus/Nexus, etc). We redefine a VC firm as CVC if the firm has only one parent corporation and its industry classification is not financial institution. We exclude those CVCs that we cannot identify their parent corporations or those CVCs with parent corporations classified as financial institutions. With the new CVC definition, we have 442 CVC firms in the final sample. We use two measures to identify the characteristics of start-ups.[17] The first measure is a dummy variable that takes a value of 1 if a start-up has at least one CVC investor and 0 if it is fully financed by IVCs. The second measure is a continuous variable calculated as the percentage of the investment amounts from CVC funds scaled by the start-up's total investment amount. This measure proxies for the degree of participation by CVC funds in a start-up.

To test whether CVC funds have different investment amounts, duration periods, and exit strategies compared with IVC funds, we construct three dependent variables at the start-up level: the total investment amount, the duration before the exit, and the exit route (IPO or acquisition). To measure the amount invested in a start-up, we add up the disclosed investment amounts across all rounds.[18] We define the duration before the exit as the difference in days between the start-up's exit date (IPO date or acquisition date) and the date at which it received its first investment from VC investors. Finally, a start-up's exit strategy is denoted by an indicator variable *IPO*, which equals 1 if a start-up exits through an IPO and 0 if it exits through an acquisition.

We include controlling variables, such as fund size, fund age, syndicate size, stock market condition, investment rounds, and so on, according to the literature. There are detailed descriptions of the controlling variables in later sections. Appendix B provides the definition of all the variables used in the regressions.

According to our sample, there are around 60 industries based on 2-digit SIC code, among which 14 industries have more than 20 start-ups in each industry. The major industries are the Business Service, Chemicals and Allied Products, Industrial Machinery and Equipment, Electronic Equipment, Communications, and Engineering Services, where venture capital investments are more common. About half of the start-ups in the sample are from the Business Service industry.[19]

Table 1 presents the summary statistics of the variables. In our sample, around 30% of the start-ups are partially financed by CVC funds, whereas the rest are financed exclusively by IVC

acquisition date.

[17] See Chemmanur, Loutskina and Tian (2011) for reference.

[18] The ThomsonOne database displays both the disclosed and the estimated investment amounts for start-ups. To calculate the total investment amount for a certain start-up, we use the disclosed amount.

[19] We do not exclude the start-ups classified as financial institutions (i.e., SIC code between 6000 and 6999) in the following empirical analysis, but we check the robustness of our results by excluding the financial institutions, the results remain the same. The results without financial institutions are available upon request.

funds. Moreover, 32% of the start-ups exit through IPOs, and 68% exit through acquisitions.

The Pearson pairwise correlation between the indicator variable *CVC* and *Investment Amount* is 0.14 or between *CVC* and *Duration* is around 0.1. The correlation between *Duration* and *Investment Amount* is only 0.07. These correlations mitigate the concern that the main variables are highly correlated and may cause potential multicolinearity problems in the multivariate analysis of exit strategies.[20]

8 Empirical Results

8.1 Univariate Evidence

We start our analysis by providing some univariate evidence on the differences in the investment and duration strategies of CVC- and IVC-backed start-ups. Table 2 presents a univariate comparison of these two groups of start-ups. There are significant differences between them across several dimensions. For instance, CVC-backed start-ups have higher investment levels than IVC-backed start-ups. The average amount invested in CVC-baked start-ups is approximately 51 million USD, whereas the average amount invested in IVC-backed start-ups is approximately 25 million USD. Consistent with Gompers and Lerner (2000), the difference in investment amounts between these two groups is approximately 25 million USD and is statistically significant at the 1% level. Furthermore, there is a large gap between the average duration periods of these two types of start-ups. The average duration for CVC-backed start-ups is $1,916$ days, whereas the average duration for IVC-backed start-ups is $1,614$ days. This difference is statistically significant. However, the difference in the IPO exit rates is not very significant. Moreover, in contrast with IVC-backed start-ups, CVC-backed start-ups have more investment rounds and larger syndicate size, start investment at earlier stages and tend to exit at later stages of the business cycle.

It is also interesting to investigate whether CVC and IVC funds select different types of start-up projects and whether this difference leads to different behavior with respect to the investment amounts. To do so, we divide our successful start-ups dataset into groups based on the investment round in which CVC investors first enter.

Table 3 provides the average investment amount per round and per group. The columns denote the different investment rounds, and the rows denote the groups of start-ups differentiated by the round in which CVC investors enter. We provide statistics until group 8, in which CVCs enter the project in the eighth investment round.[21] The numbers in bold represent the average investment amount at the point when CVC funds join the venture. For example, the first row (Gr.0) describes the group of start-ups that only receive IVC financing. The third row (Gr.2) includes the group of start-ups that begin receiving CVC investments in the second round. The average investment amount in round 1 for the start-ups that never receive CVC financing (Gr. 0) is approximately 5.54 million USD, whereas it is 5.31 million USD for those that receive CVC funds in round 2. These

[20]The correlation matrix of all the variables is available upon request.

[21]In certain start-ups, CVC funds only enter after the eighth round. Because the number of these ventures is small, we do not show the details of those cases.

numbers are considerably lower than the 9.68 million USD received by the CVC-backed start-ups in round 1. A similar effect appears for all rounds. On the one hand, before CVC funds begin investing in start-ups, there is no strong difference in the investment amounts, that is, IVC funds seem to invest in start-ups of similar quality. On the other hand, there is always an important increase in the investment amounts once the CVC funds enter.[22] This finding suggests that there is no apparent start-up selection bias in terms of investment amount. These statistics mitigate some concern that CVC funds self-select to invest in high-quality start-ups.[23] It is worth mentioning that most CVC funds start investing during the early rounds. One-third of the start-ups receive CVC funds in the first round, and approximately 52% of them obtain CVC financing during the first two rounds. This result is consistent with the findings of Chemmanur, Loutskina, and Tian (2011) but differ from those of other papers, which suggest that CVC funds typically enter start-ups in the later investment rounds (Hellmann, Lindsey, and Puri, 2008; Masulis and Nahata, 2009; Dushnitsky and Shapira, 2010).

8.2 Fund Characteristics and Investment Strategy

Next, we examine the impact of CVC funds on the investment strategies of start-ups in a multivariate framework (H1). Specifically, we use the following ordinary least squares model to estimate this effect:

$$\ln \mathit{Investment\ Amount}_i = \alpha_0 + \alpha_1 CVC_i + \sum_{k=1}^{10} \alpha_k Z_{ki} + \epsilon_i \tag{6}$$

In the above model, the variable *Investment Amount* denotes the total investment amount at the start-up level. The indicator variable CVC captures whether a start-up receives CVC financing.

Based on the prior literature, we also control for a set of variables that may explain the total investment amount based on characteristics in addition to the investor type. For instance, Masulis and Nahata (2009) argue that if a start-up and the parent company of the CVC investor are in the same industry, the latter is likely to have more information about the potential value of the venture than it would if the two firms operated in different industries. This argument leads to the endogeneity concern that CVC funds invest more because they have more precise information about the start-ups. To control for such effects on the investment amount, we include an indicator variable, *CVC Strategic Rel.*, which is 1 if the parent company and the start-up have the same four-digit SIC code (i.e., they are competitors in the same industry), and 0 otherwise.[24] In addition, we control for both syndicate size (i.e., the number of VC firms in one syndicated deal) and syndicate leader type. A syndicated deal involves two or more VC firms that take equity stakes in an investment for a future joint payoff (see, for example, Toldra, 2010). A larger syndicate size indicates that there are more investors in the start-up, which may lead to a higher investment

[22]The t statistics of the pairwise comparison of the investment amount across all rounds and groups are available upon request.

[23]We do not claim that CVC funds and IVC funds invest in the same type of start-ups. Start-ups with CVC financing and those with IVC financing can be different in other unobserved characteristics except investment amount. We discuss the endogeneity problem of missing variables in later sections.

[24]We also define the indicator variable *CVC Strategic Rel.* using a two-digit SIC code. The regression results are similar to those defined with a four-digit SIC code. These empirical results are available upon request.

amount. The syndicate leader is the main fund in the syndicated deal. This fund organizes the syndicate, and arranges and manages the project. The variable *Syndicate Leader CVC* takes the value 1 if the fund that provides the maximum investment amount in a syndication is a CVC firm and 0 otherwise (Masulis and Nahata, 2009). If a CVC fund is the leader, it has more decision power that, according to our theoretical prediction, should lead to an increase in the investment amounts. Furthermore, more mature VC funds have more experience, better reputations, and richer resources, which are likely to lead to higher investment levels in start-ups. Thus, we also add the age of the VC fund as a proxy for the VC experience in the regression. This variable is measured as the average fund age across all funds investing in start-ups. To control for the influence of the starting date of the investment on the investment amount, we include an indicator variable, *Early Invest Stage*, which is 1 if the first investment is made at the seed or an early stage of the start-up's development. Finally, the Business Service Industry (SIC=73) covers almost half of the observations in the sample. To control for the possibility that our results are mainly driven by this particular industry, we include an indicator variable, *Industry 73*, in the analysis. *Industry 73* takes the value of 1 if a start-up belongs to the Business Service Industry and 0 otherwise. We also include the industry market to book value, denoted by *Industry MB*, to control for the effect of industry-level growth opportunities on the investment amount.[25]

Panel A of Table 4 presents the results of the regressions that estimate Hypothesis 1. In Model 1, the estimated coefficient of CVC is positive and statistically significant at the 1% level. This finding is consistent with the theoretical prediction that CVC funds invest more in start-ups than IVC funds do. The economic magnitude is also significant. The amounts invested in start-ups financed by CVC funds are 18% greater than the amounts invested in those financed by IVC funds. Moreover, if the syndicate leader of a start-up is a CVC investor, the start-up experiences an additional 28% increase in its investment level. In Model 2, we redefine the *VC fund age* and calculate it as the average age of IVC funds. Managers of younger IVC funds are more eager to show success than managers of older IVC funds. Therefore, the effect of age of the fund should be stronger for IVC funds than for CVC funds that may stay in business for strategic reasons other than success. The results are robust to this alternative definition of fund age. Furthermore, in Models 3, we use the percentage of CVC investments as an alternative measure to capture the influence of CVC financing. The results are similar to those of Models 1 and 2. Additionally, more investment rounds, larger fund sizes, larger syndicate sizes, industries with more growth opportunities, and the existence of non-Business Service industries lead to increased investments in start-ups. We do not find any significant effect of the CVC funds' relationships with the start-ups (competitive or not) on the amounts invested in the start-up. Taken together, the results in Panel A of Table 4 strongly support the prediction that CVC-backed start-ups are associated with higher investment levels.

[25]Instead of using *Industry 73* and *Industry MB* to control for the industry effect, we also try to control for industry fixed effect on the investment strategy and find that the empirical results are very similar to those in Table 4. These empirical results are available upon request. We do not control for *Industry MB*, industry and year fixed effects at the same time because of multicollinearity concern.

8.3 Fund Characteristics and Duration Strategy

Our theoretical model predicts that the start-ups financed by CVC funds stay longer than those financed by IVC funds (H2). To test this prediction, we use a survival model because the dependent variable represents the period of time before the exit. The model is as follows:

$$Duration_i = \alpha_0 + \alpha_1 CVC_i + \sum_{k=1}^{8} \alpha_k Z_{ki} + \epsilon_i \tag{7}$$

The dependent variable in Equation (7) is the duration of the start-up before its exit, as measured by the number of days between the exit date and the first investment date. As before, the main independent variable of interest is CVC, which indicates whether the start-up receives financing from CVC funds. We include the same set of control variables used in the regression that estimates the effect of CVC funds on the total investment amount.[26] We also estimate three regression models. We use the indicator variable CVC to indicate that a start-up is financed by CVC funds for Models 1 and 2. In Models 3, we use the percentage of the investment financed by CVC funds as the independent variable.

We assume a Weibull distribution of the residual values and parametrically estimate the survival model.[27] The hazard rates of the regression are shown in Table 4 Panel B. Consistent with Hypothesis 2, the CVC-backed start-ups stay longer before exiting than the IVC-backed start-ups. Moreover, the start-ups that receive funds from larger and more mature VC funds have a longer duration. Start-ups from industries with more growth opportunities also stay longer before the exit. However, the start-ups with more investment rounds and those with a larger syndicate size seem to stay for a shorter period of time.

Finally, the impact of the competitive relationship between CVC funds and start-ups on duration is not significant. Together with the similar finding concerning the level of investment, this result suggests that whether CVC investors have more information about the start-ups and whether the CVC's parent company and the start-up are competitors do not appear to affect the investment and duration strategies.

[26]To control for the industry effect on duration, we use the same strategy as that for investment amount. We include either industry market-to-book value or industry fixed effect. The results remain similar.

[27]The assumption of a Weibull distribution is based on the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). We also tried the semi-parametric estimation (COX estimation) of the survival model. However, the post-estimation PH-test rejected the proportional hazards assumption of the COX estimation.

8.4 Fund Characteristics and Start-up Exit Strategies

8.4.1 Logistic and OLS Regressions

In this section, we test the direct effect of CVC funds and their indirect impacts through investment and duration decisions on start-ups' exit strategies (H3) using the following model:

$$\begin{aligned} Exit_i = \alpha_0 + \alpha_1 CVC_i + \alpha_2 \ln Duration(Days)_i \\ + \alpha_3 \ln Investment\ Amount_i + \sum_{k=1}^{9} \alpha_k Z_{ki} + \epsilon_i \end{aligned} \tag{8}$$

The dependent variable *Exit* is an indicator variable that takes the value 1 if a start-up exits through an IPO and 0 if it exits through an acquisition. The main independent variables of interest are the CVC, *Investment Amount* and *Duration (Days)*. We also control for other variables that may explain the exit strategy. For instance, Aghion and Bolton (1992) and Cumming (2008) note that the balance of controlling power between the entrepreneur of a start-up and the VC investors may influence the exit strategy. Entrepreneurs are likely to prefer IPOs over acquisitions because the entrepreneurs can continue to enjoy the private benefits of running the firm in the event of an IPO, whereas venture capitalists may prefer acquisitions over IPOs because of the significant costs involved in preparing IPOs. Thus, the likelihood of IPOs increases as the controlling power of entrepreneurs increases. To account for this effect, we include the indicator variable *Later Exit Stage* in the regression. This variable is equal to 1 if the start-ups exit at the expansion or later stages and 0 if they exit at the seed or early stages. The intuition behind this variable is that entrepreneurs tend to have more control over their technologies and/or business operations if their start-ups exit in the expansion or later stages of the business cycle (Smith, 2005; Schwienbacher, 2009). Furthermore, we also control for the stock market performance three months prior to the start-ups' exit dates (three-month MSCI). Presumably, a strong stock market performance can increase the value of IPO exits.[28]

Table 5 reports the results of the regressions that estimate Hypothesis 3. In Model 1, we investigate the effect of CVC financing on the exit strategy of start-ups without controlling for the duration effect and investment amount effect. We find that start-ups backed by CVC funds are more likely to have an IPO exit than those backed by IVC funds. This positive effect is statistically significant. On the contrary, in Model 2, we control for the duration effect and investment amount effect but not for the investor type. The result shows that duration has a statistically significant and negative effect on the likelihood of IPO exit while investment amount has a statistically significant and positive effect. When we control for investor type, as well as duration and investment amount effect in Models 3, 5, 6 and 7 the effect of CVC funds on an IPO exit is not statistically significant

[28] We do not include *Early Invest Stage* in this regression because we control for the *Duration*, which is defined as the number of days (or years) between the first investment date and the exit date. In addition, we control for the *Late Exit Stage*, which captures the stage at which start-ups exit. These two variables account for the effect of the first investment stage. Similar to the regressions in Table 4, we control for the year fixed effect and use *Industry MB* and *Industry 73* to control for the industry effect on the exit strategy. However, we also control for the industry characteristics using industry fixed effect. The results remain the same. These results are available upon request.

when either the CVC indicator variable or the percentage of investment amounts made by CVC funds is used. These results, together with the results from Models 1 and 2, provide strong support for Hypothesis 3*c* and suggest that the type of investor does not directly impact the exit strategy over and above the effects of duration and investment amount. However, CVC funds indirectly influence the exit strategy through the investment amounts provided to the start-up and the duration of the start-up. Specifically, the coefficient of *Ln(Investment Amount)* is positive and statistically significant. In terms of economic magnitude, a 1% increase in the investment amount increases the probability of an IPO exit by 0.079%, as evidenced in Model 7. Furthermore, a longer duration leads to a significantly lower probability of an IPO exit. A 1% increase in the duration decreases the probability of an IPO by 0.027%. These results are robust to both OLS and Logistic regression specifications and provide strong support for Hypotheses 3*a* and 3*b*.

In Model 4, we include a quadratic form of the duration to test the non-linear effect of duration on the exit strategy. The coefficient of this quadratic duration term is positive and statistically significant at the 5% level, which suggests that the negative effect of the duration on the probability of an IPO exit is stronger if the duration is shorter. To better understand this quadratic effect, we run similar regressions for the start-ups with durations less than eight years and more than eight years, respectively. These subsample analyses confirm that the effect of duration on the likelihood of an IPO exit has two regions. The effect is linear and significant for the start-ups whose durations are less than eight years. Conversely, the effect is insignificant in a linear or quadratic manner if the duration for the start-up is more than eight years. In our dataset, the average duration of the start-ups is approximately four to five years, and more than 87% of the start-ups in our sample stay for less than eight years. Therefore, the quadratic effect of the duration does not alter our conclusions regarding the effect of duration on the exit strategy.

Furthermore, Table 5 provides additional evidence on the effect of the discount rate on the exit strategy. Specifically, the effect of the VC fund size on the probability of an IPO is not statistically significant if both the duration and investment effects are controlled for in Models 2 to 7. However, in Model 1, when we remove the duration and investment amount, the estimated coefficient on *Ln (VC Fund Size)* is positive and statistically significant. The effect of the VC fund size is particularly interesting because the discount rate of a fund is likely to decrease with its size as larger funds have more resources than smaller funds. Thus, the fund size should have effects on investment, duration, and exit strategies that are similar to the effects of the type of investor. According to Tables 4, the fund size also positively impacts the investment amount and the duration as the variable CVC, although Table 5 shows that fund size does not directly affect the exit strategy.

Moreover, the sign of the control variables are also as expected. For instance, a stronger stock market performance three months before the exits significantly increases the likelihood of IPOs. The estimated coefficient on the variable *Later Exit Stage* is positive and statistically significant. This finding is consistent with the results of the prior literature, which states that start-ups are more likely to exit through IPOs if entrepreneurs have controlling power (Cumming, 2008). Whether the start-ups and the parent companies of CVC funds are in the same industry has no significant impact on the exit strategy.

8.4.2 Endogeneity Concerns - Instrumental Variable Approach

A potential concern is that the results in Table 5 can also be explained by the fact that CVC funds may be better at selecting high-quality start-ups that are more likely to exit via IPOs. To address this endogeneity concern, we use the instrumental variable approach. Specifically, we construct two instruments. One instrument is constructed based on the intuition that a start-up is more likely to receive CVC financing if that start-up is looking for VC financing in a year and industry when there is plenty of CVC funding (Chemmanur, Loutskina, and Tian, 2011). This instrument measures the total investments made by CVC funds in a given year and in a given two-digit SIC industry that the start-ups operate, as a percentage of the total VC investments for that year. It captures the tendency of CVC funds to invest in a particular industry. This tendency is highly correlated with the likelihood that they will invest in firms that belong to this industry.

Following the same intuition, we build up another instrument which measures the total investments made by CVC funds in a given year and in a given geographic area that the start-ups operate as a percentage of the total VC investments for that year in the same geographic area. We measure the geographic area by the U.S. Metropolitan Statistical Areas (MSA). This instrument captures the aggregate CVC funding near the start-ups' operating location in a given year. Start-ups should have a higher probability to get CVC financing if there is more CVC funding nearby. We believe that both instruments reasonably satisfy the exclusion restriction because the aggregate CVC funding supply at industry level or at MSA level can hardly influence the start-up level exit strategy.

Table 6 shows the second-stage regression results using IV approach for Models 3 to 6 of Table 5. Results suggest that the instruments significantly explain the CVC variable. The robust F-statistic is around 185 for Models 3 to 5 and 122.5 for Model 6. The robust F-statistics are well above the critical value suggested by Stock, Wright, and Yogo (2002) to be a strong instrument.[29] Furthermore, the Hansen-Sargan J-statistics from the over-identifying test have p-values larger than 0.37. These results assure the appropriateness of the two instrumental variables. Consistent with the OLS and Logistic results, the instrumented variable CVC has a negative but insignificant effect on the likelihood of an IPO exit. This finding suggests that our results are robust to the IV identification strategy.

9 Additional Analysis

9.1 Fund Characteristics and Rate of Successful Exits.

Our theoretical model also predicts the indirect effects of the amounts invested by CVC funds on the rate of successful exits by start-ups (Hypothesis 4). To test these effects, we use a dataset that includes both the successful and unsuccessful start-ups in the U.S. with the first investment

[29]Stock, Wright, and Yogo (2002) develop the suggested critical F-statistics for different numbers of instruments. In the case of two instruments, the F-statistic should be at least 11.59 to ensure that the instruments are not weak.

year from 1980 to 2008. We construct a new dependent variable, *Failure*, which is equal to 1 if a start-up has neither IPO exit nor acquisition exit, as indicated by the ThomsonOne database and SDC Global New Issues Database, and 0 if it exits through an IPO or an acquisition route. In this case, the duration of the start-ups is defined as the number of days between the first and last investment dates. We control for a set of explanatory variables similar to that in the IPO exit regression.[30]

Table 7 presents the results of the Logistic regressions of Hypothesis 4. In Models 1 and 2, we use the CVC indicator variable and the percentage of the amount invested by the CVC funds to measure whether a start-up is backed by CVC funds. We find that funds characteristics, duration, investment amount, and the identity of the syndicate leader (i.e., whether the CVC is the syndicate leader) do not have significant influence on the probability of failure. These results support our theoretical predictions, which state that the fund characteristics (CVC funds vs. IVC funds) and the duration do not have any impact on the rate of successful exits.

Our model also predicts that the investment amount has a positive effect on the rate of successful exists, whereas the empirical impact is not significant. This discrepancy may be due to the above-mentioned poor quality of the ThomsonOne dataset with regard to the set of failures because of information restrictions. Our theoretical predictions regarding the impact of CVC funds on the exit strategy are closer to those of Chemmanur and Loutskina (2008), who find that CVC investments in start-ups lead to a higher, albeit not significant, rate of successful exit. Furthermore, a higher investment level increases the rate of success, as predicted by our theoretical model. Other empirical studies also confirm that CVC-backed start-ups perform better than IVC-backed start-ups. For example, Dushnitsky and Shapira (2010) find that CVC-backed start-ups exhibit a higher rate of successful portfolio exits. Depending on the CVC portfolio manager's compensation incentives, the increase in the rate of successful exits ranges from 9.7% to 20%.

9.2 Robustness Tests

One potential concern is that the investment amount, duration, exit strategy, and type of investor may depend on the potential value of the start-up (parameter V in the theoretical model).[31] This dependence would bias the coefficient estimates on the main independent variables. We have used an instrument variable approach to mitigate the endogeneity problem in the estimation of the exit strategy. While the instrument variable used is suitable for the exit strategy, it is not applicable to the investment and duration strategies.[32]

We use the following method to mitigate the concern regarding this omitted, correlated variable in the estimations of the investment and duration strategies. We split our sample into two groups.

[30] We exclude some control variables, such as the industry market-to-book value and fund age, because of data insufficiency. Furthermore, we do not observe the dates on which the start-ups are defined as failure. Hence, we also remove the control variables that require exact defunction dates.

[31] Our analysis in Section 8.1 tried to mitigate the concern about the possible selection bias between the CVC and IVC project exits.

[32] The instrument variable is the percentage of the CVC investment over all of the investments made at the industry level. This variable can be highly correlated with the firm-level investment amount, which does not satisfy the exclusion restriction of the IV estimation.

The first group is composed of those start-ups that exit through the IPO market, whereas the second group comprises those that exit through the acquisition market. According to our theoretical model, the start-ups that exit through the IPO market have higher values than those that exit through acquisitions. Within each subsample, the start-ups should have similar potential values. We re-run the regressions using either the investment amount or the duration as the dependent variable for these two subsamples. Table 8 presents the corresponding results.

For the investment strategy in Table 8, the results indicate that the main conclusions still hold for both types of start-ups (i.e., those that exit through IPOs and those that exit through acquisitions). Specifically, in the two subsamples, we find that the CVC-backed start-ups receive significantly higher investment amounts. However, the effect of CVC as a syndicate leader on the investment amount disappears for the start-ups with acquisition exits.

For the duration strategy in Table 8, the CVC investment significantly increases the duration of the start-ups in the acquisition market. Interestingly, whether the start-ups are backed by CVC funds is not important in determining the duration of the start-ups that issue IPOs. This result matches our theoretical predictions: the decision regarding the duration or the level of information only matters if the start-ups go to the acquisition market.

We find that CVC funds enter start-ups in different investment rounds. Hence, another potential endogeneity problem is that if start-ups stay longer in the market before exiting (i.e., longer duration), there is a higher probability that they will receive investments from CVC funds. To control for this effect, we re-estimate the investment and duration regressions using a subsample of our dataset with successful start-ups. This subsample only includes the IVC-backed start-ups and the CVC-backed start-ups that receive their first CVC investments within the first two investment rounds. Table 9 presents the corresponding results. The results are consistent with our previous findings with respect to the impact of CVC funds on investment and duration strategies. In fact, these effects become statistically more significant in this subsample.

10 Conclusion

In this paper, we study the optimal initial and exit decisions made by start-ups. In particular, we focus on the difference in behavior between CVC-backed start-ups and IVC-backed start-ups.

In our theoretical analysis, we find that CVC-backed start-ups have longer durations before their exits and larger investment levels than those financed by IVC funds. In turn, these properties lead to higher rates of successful exit and to two opposite impacts on the likelihood of an IPO exit. A longer duration, which implies the existence of more information in the acquisition market, increases the probability that the start-up searches for an acquirer. Conversely, higher investment levels, which increase the value of the start-up, encourage an IPO exit.

We find strong empirical support for our theoretical predictions by using data from the ThomsonOne and the SDC Global New Issues databases. The presence of CVC financing leads the start-ups to higher levels of investment and to stay longer before exiting. Moreover, the effect of the venture capital funds' characteristics on start-ups' exit strategies can be explained by the investment and duration decisions. Shorter durations and greater investment levels lead to a greater likelihood of IPO exits. However, once these effects are considered, whether the venture capital fund is corporate or independent does not significantly influence the exit decision.

A Theoretical Proofs

Proof of Proposition 2. The proof follows the discussions before Propositions 1 and 2. We just notice that Equation (2) gives a solution $p^*(V) \leq 1$ if $V \leq \frac{F}{\beta - \frac{m}{2}}$, in which case $p^*(V) = \frac{F}{(\beta - \frac{m}{2})V}$. Therefore, in this region of V, the deal price for a startup with potential value V is $m\frac{p^*(V)}{2}V = \frac{mF}{2\left(\beta - \frac{m}{2}\right)}$. If $V > \frac{F}{\beta - \frac{m}{2}}$, then $p^*(V) = 1$ and the deal price is $\frac{1}{2}mV$. □

Proof of Proposition 3. Given that V is uniformly distributed over the interval $\left[f(I), \hat{V} + f(I)\right]$, we have that $1 - F(0) = \frac{\hat{V} + f(I)}{\hat{V}}$. Therefore, the rate of IPO exits over the total successful exits is either

$$\frac{\hat{V}}{\left(\hat{V} + f(I)\right)} \int_{\frac{F}{\beta - m}}^{\hat{V} + f(I)} \left[1 - \frac{F}{(\beta - m)\, V}\right] \frac{1}{\hat{V}} dV, \tag{A.1}$$

or

$$\frac{\hat{V}}{\left(\hat{V} + f(I)\right)} \int_{\frac{F}{\beta - \frac{m}{2}}}^{\hat{V} + f(I)} \left[1 - \frac{F}{(\beta - \frac{m}{2})\, V}\right] \frac{1}{\hat{V}} dV, \tag{A.2}$$

depending on the information about p. Moreover,

$$\frac{\partial}{\partial I} \left(\frac{\hat{V}}{\left(\hat{V} + f(I)\right)} \int_{\frac{F}{\beta - m}}^{\hat{V} + f(I)} \left(1 - \frac{F}{(\beta - m)\, V}\right) \frac{1}{\hat{V}} dV \right) =$$

$$\frac{f^{'}(I)}{\left(\hat{V} + f(I)\right)^2} \left(\left(\hat{V} + f(I) - \frac{F}{(\beta - m)}\right) - \int_{\frac{F}{\beta - m}}^{\hat{V} + f(I)} \left(1 - \frac{F}{(\beta - m)\, V}\right) dV \right) =$$

$$\frac{f^{'}(I)}{\left(\hat{V} + f(I)\right)^2} \left(\int_{\frac{F}{\beta - m}}^{\hat{V} + f(I)} \frac{F}{(\beta - m)\, V} dV \right) > 0.$$

Therefore, the expression (A.1) is increasing in I. A similar argument allows us to prove that (A.2) is also increasing in I. □

Proof of Lemma 1. The expected utilities $EU_o(I)$ and $EU_{oo}(I)$ are computed as the integral over the set A of all the possible values of (V, p) that can exist given I. We divide this set into three subsets: We denote A_1 the subset composed of all values for which the start-up seeks an acquirer in both cases; we denote A_2 the subset of all values for which the start-up goes to an IPO in both cases; and we denote $A_3$the subset of values of (V, p) for which the start-up seeks an acquirer if the acquirer knows $p$whereas it goes to an IPO if the acquirer does not know p.

First, the value of the start-up profit function is the same in $EU_o(I)$ and $EU_{oo}(I)$ in $(V, p) \in A_2$ because $U_o(V, p) = U_{oo}(V, p)$ in this region of parameters. Second, the integral of the expected value for all the parameters (V, p) in A_1 must also be the same in $EU_o(I)$ and $EU_{oo}(I)$ because, for any V, if the acquirer does not know p, the deal price reflects the expected value given the set of ps that go to the acquisition market, multiplied by the bargaining power m. Finally, in A_3, the value for the start-up in the expression $EU_o(I)$ is higher than in $EU_{oo}(I)$ for the reason we have provided in the main text: if the acquirer does not know p, the equlibrium deal price for the parameters in A_3 is lower than the expected value in the start-up goes to an IPO.

Therefore, $EU_o(I)$ is always higher than $EU_{oo}(I)$. Moreover, the inequality is strict as long as A_3 is non-empty, which always holds if IPOs can happen (as ensured by our assumptions).

□

Proof of Proposition 6. The optimal values d^* and I^* are characterized by

$$\frac{\partial U}{\partial d}(d^*, I^*) = 0 \tag{A.3}$$

$$\frac{\partial U}{\partial I}(d^*, I^*) = 0. \tag{A.4}$$

We differentiate Equations (A.3) and (A.4) and solve the system to obtain that, at (d^*, I^*),

$$\frac{\partial I^*}{\partial r} = -\frac{\Lambda_I}{\Delta} \tag{A.5}$$

$$\frac{\partial d^*}{\partial r} = -\frac{\Lambda_d}{\Delta}, \tag{A.6}$$

where

$$\Lambda_I = \frac{\partial^2 U}{\partial d^2}\frac{\partial^2 U}{\partial I \partial r} - \frac{\partial^2 U}{\partial I \partial d}\frac{\partial^2 U}{\partial d \partial r}$$

$$\Lambda_d = \frac{\partial^2 U}{\partial I^2}\frac{\partial^2 U}{\partial d \partial r} - \frac{\partial^2 U}{\partial I \partial d}\frac{\partial^2 U}{\partial I \partial r}$$

and

$$\Delta = \frac{\partial^2 U}{\partial I^2}\frac{\partial^2 U}{\partial d^2} - \left(\frac{\partial^2 U}{\partial I \partial d}\right)^2.$$

Before the analysis of the second derivatives of the function $U(d, I)$, we analyze the functions $EU_o(I)$ and $EU_{oo}(I)$.

Taking into account that $d\Gamma(V; I) = \frac{1}{\widehat{V}}$, and Propositions 1 and 2, we have

$$\begin{aligned} EU_o(I) \quad = \quad & \int_0^{\frac{F}{\beta-m}} \int_0^1 mpV\,dp \frac{1}{\widehat{V}} dV + \int_{\frac{F}{\beta-m}}^{\widehat{V}+f(I)} \int_0^{\frac{F}{(\beta-m)V}} mpV\,dp \frac{1}{\widehat{V}} dV + \\ & \int_{\frac{F}{\beta-m}}^{\widehat{V}+f(I)} \int_{\frac{F}{(\beta-m)V}}^1 (\beta pV - F)\,dp \frac{1}{\widehat{V}} dV = \\ & \frac{1}{2\widehat{V}} \int_0^{\frac{F}{\beta-m}} mV\,dV + \frac{1}{2\widehat{V}} \int_{\frac{F}{\beta-m}}^{\widehat{V}+f(I)} m \frac{F^2}{(\beta-m)^2 V} dV + \\ & \frac{1}{\widehat{V}} \int_{\frac{F}{\beta-m}}^{\widehat{V}+f(I)} \left(\frac{1}{2}\beta V - \frac{1}{2}\frac{\beta F^2}{(\beta-m)^2 V} - F + \frac{F^2}{(\beta-m)V}\right) dV = \\ & \frac{1}{2\widehat{V}} \int_0^{\frac{F}{\beta-m}} mV\,dV + \frac{1}{\widehat{V}} \int_{\frac{F}{\beta-m}}^{\widehat{V}+f(I)} \left(\frac{1}{2}\beta V + \frac{1}{2}\frac{F^2}{(\beta-m)V} - F\right) dV, \end{aligned} \tag{A.7}$$

and similarly,

$$
\begin{aligned}
EU_{oo}(I) \;=\;& \int_0^{\frac{F}{\beta-\frac{m}{2}}} \int_0^1 \frac{1}{2} mV dp \frac{1}{\widehat{V}} dV + \int_{\frac{F}{\beta-\frac{m}{2}}}^{\widehat{V}+f(I)} \int_0^{\frac{F}{(\beta-\frac{m}{2})V}} \frac{1}{2} m \frac{F}{\left(\beta-\frac{m}{2}\right)} dp \frac{1}{\widehat{V}} dV + \\
& \int_{\frac{F}{\beta-\frac{m}{2}}}^{\widehat{V}+f(I)} \int_{\frac{F}{(\beta-\frac{m}{2})V}}^{1} (\beta p V - F)\, dp \frac{1}{\widehat{V}} dV = \frac{1}{2\widehat{V}} \int_0^{\frac{F}{\beta-\frac{m}{2}}} mV dV + \\
& \frac{1}{\widehat{V}} \int_{\frac{F}{\beta-\frac{m}{2}}}^{\widehat{V}+f(I)} \left(\frac{1}{2}\beta V - \frac{1}{2} \frac{(\beta-m)\, F^2}{\left(\beta-\frac{m}{2}\right)^2 V} + \frac{F^2}{\left(\beta-\frac{m}{2}\right) V} - F \right) dV. \qquad \text{(A.8)}
\end{aligned}
$$

From the expressions of $EU_o(I)$ and $EU_{oo}(I)$ we obtain

$$
EU_o'(I) = \frac{f'(I)}{\widehat{V}} \left(\frac{1}{2}\beta \left(\widehat{V} + f(I)\right) + \frac{1}{2} \frac{F^2}{(\beta-m)\left(\widehat{V}+f(I)\right)} - F \right), \qquad \text{(A.9)}
$$

$$
EU_{oo}'(I) = \frac{f'(I)}{\widehat{V}} \left(\frac{1}{2}\beta \left(\widehat{V} + f(I)\right) - \frac{1}{2} \frac{(\beta-m)\, F^2}{\left(\beta-\frac{m}{2}\right)^2 \left(\widehat{V}+f(I)\right)} + \frac{F^2}{\left(\beta-\frac{m}{2}\right)\left(\widehat{V}+f(I)\right)} - F \right). \qquad \text{(A.10)}
$$

As it is intuitive and easy to check, $EU_o'(I) > 0$ and $EU_{oo}'(I) > 0$.

We now analyze the sign of the second derivatives of the function $U(d, I)$.

$$
\frac{\partial^2 U}{\partial d^2}(d^*, I^*) = e^{-rd}[h''(d) - rh'(d)][EU_o(I) - EU_{oo}(I)]. \qquad \text{(A.11)}
$$

In Equation (A.11), $h'(d) > 0$ and $h''(d) < 0$. Moreover, Lemma 1 implies that $EU_o(I) > EU_{oo}(I)$. Therefore, $\frac{\partial^2 U}{\partial d^2}(d^*, I^*) < 0$.

$$
\frac{\partial^2 U}{\partial I \partial r}(d^*, I^*) = -d < 0. \qquad \text{(A.12)}
$$

$$
\frac{\partial^2 U}{\partial I^2}(d^*, I^*) = e^{-rd}[h(d) EU_o''(I) + (1-h(d)) EU_{oo}''(I)] < 0 \qquad \text{(A.13)}
$$

because

$$
\begin{aligned}
EU_o''(I) =& \frac{f''(I)}{\widehat{V}} \left(\frac{1}{2}\beta \left(\widehat{V} + f(I)\right) + \frac{1}{2} \frac{F^2}{(\beta-m)\left(\widehat{V}+f(I)\right)} - F \right) + \\
& \frac{1}{2} \frac{f'(I)^2}{\widehat{V}} \left(\beta - \frac{F^2}{(\beta-m)\left(\widehat{V}+f(I)\right)^2} \right) < 0
\end{aligned}
$$

Similarly, $EU_{oo}''(I) < 0$ if $f(I)$ is concave enough.

$$
\frac{\partial^2 U}{\partial d \partial r}(d^*, I^*) = -e^{-rd}[h(d) EU_o(I) + (1-h(d)) EU_{oo}(I)] < 0. \qquad \text{(A.14)}
$$

Finally

$$
\frac{\partial^2 U}{\partial I \partial d}(d^*, I^*) = -r + e^{-rd} h'(d)[EU_o'(I) - EU_{oo}'(I)],
$$

with

$$EU_o'(I) - EU_{oo}'(I) = \frac{f'(I)}{\widehat{V}} \frac{1}{2} \frac{F^2}{\left(\widehat{V} + f(I)\right)} \frac{m^2}{4\left(\beta - m\right)\left(\beta - \frac{m}{2}\right)^2} > 0.$$

Therefore, investment and duration may be complement or substitute, depending on the comparison of the two terms. If they are complements, i.e., $\frac{\partial^2 U}{\partial I \partial d}\left(d^*, I^*\right) \geq 0$, then $\Lambda_I > 0$ and $\Lambda_d > 0$. If they are substitutes, the same inequalities hold as long as the functions $h(d)$ and $f(I)$ are sufficiently concave, which also imply that $\Delta > 0$ (Δ is always positive in any strict maximum).

Therefore, $\frac{\partial I^*}{\partial r} < 0$ and $\frac{\partial d^*}{\partial r} < 0$, as we wanted to prove. □

B Variable Definitions

Variables	Definitions
CVC	Indicator variable equal to 1 for CVC-backed start-ups and 0 for IVC-backed start-ups
CVC_Per	Percentage of investment by CVC funds in each start-up
IPO	Indicator variable equal to 1 for an IPO exit and 0 for an aquisition exit
Investment amount	Total investment amount at start-up level, measured by disclosed equity amount (USD Million) summed over investment rounds
Duration (Days)	Difference in days between the exit date and the date at which a start-up receives the first investment from VC funds
Duration (Years)	Duration (Days) divided by 365
Investment rounds	Number of investment rounds for a start-up
Syndicate size	Number of VC funds that invest in a start-up
Syndicate leader CVC	Indicator variable equal to 1 if the VC that provides the maximum amount of investment is a CVC and 0 otherwise
VC fund size	Average size (USD Million) of VC funds that finance the start-up
CVC strategic relationship	Measure of CVC strategic competitors, indicator variable of 1 if a CVC has the same 4-digit SIC code as its start-up, and 0 otherwise
VC fund age (Years)	Average fund age across all of the funds that invest in a start-up
IVC fund age (Years)	Average fund age across IVC funds that invest in a start-up
Industry MB	Industry market-to-book value at the year at which the first CVC fund invests
3-month MSCI	MSCI return 0-3 months prior to the exit date
Later exit stage	Indicator variable equal to 1 if a start-up exits at expansion or later stage and 0 otherwise
Early Invest stage	Indicator variable equal to 1 if a start-up receives the first investment at seed or early stage and 0 otherwise
Industry 73	Indicator variable equal to 1 if a start-up is from the Business Service industry and 0 otherwise

Figure A.1 The Timeline. This figure shows the time line of the game. The start-up chooses an investment and a duration strategies at the first stage, and determines an exit strategy at the second stage.

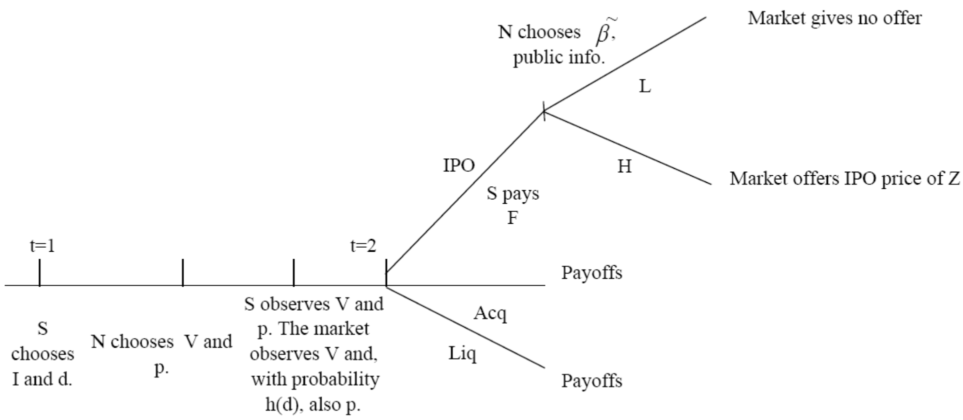

Figure A.2 The Optimal Exit Strategy. This figure depicts the optimal exit strategy. For high values of p and V, an IPO is the optimal exit route. Going to the acquisition market is the optimal start-up strategy for low values of p and V. In the shadow region, start-ups turn to an IPO if the outsiders have not learned the value of p. However, start-ups prefer going to the acquisition market if outsiders do know the value of p.

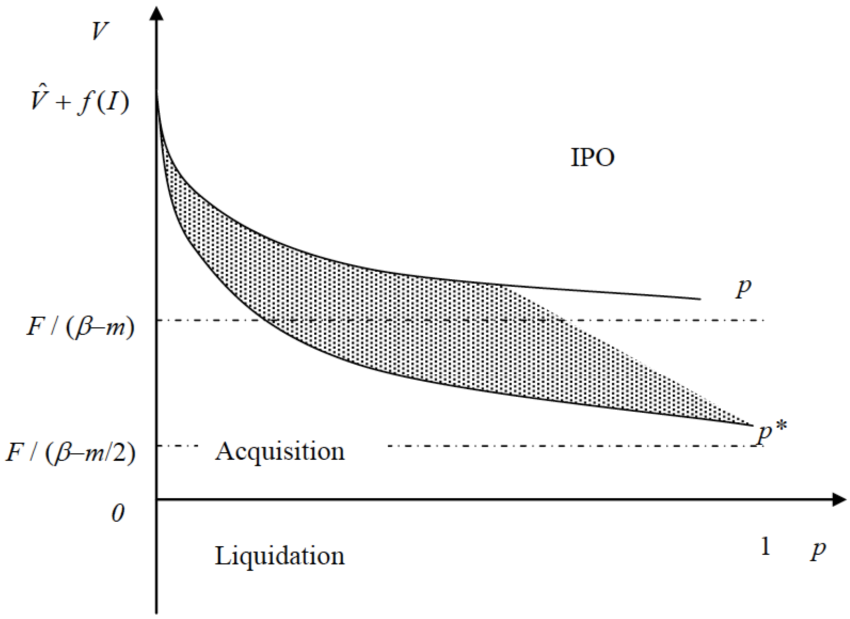

Table A.1 Summary Statistics

	No. of Obs.	Mean	Std. Dev.	Min	Max
CVC	4506	0.29	0.45	0	1
CVC_Per	4506	0.17	0.31	0	1
IPO	4506	0.32	0.47	0	1
Investment amount	4506	32.77	80.16	0.02	4653.06
Duration (Days)	4506	1700.93	1113.81	50	8310
Duration (Years)	4506	4.66	3.05	0.14	22.77
Investment rounds	4506	4.29	2.87	1	27
Syndicate size	4506	5.83	4.32	1	35
Syndicate leader CVC	4506	0.03	0.16	0	1
VC fund size	4506	219.00	390.14	0.09	6011.62
VC fund age (Years)	4473	8.05	5.25	0	24.33
IVC fund age (Years)	4506	7.23	6.11	0	29
CVC strategic relationship	4506	0.04	0.19	0	1
Industry MB	4506	14.09	22.78	0.78	432.1
3-month MSCI	4506	2968.75	1300.84	183.71	4881.96
Later exit stage	4506	0.81	0.39	0	1
Early invest stage	4506	0.72	0.45	0	1
Industry 73	4506	0.48	0.50	0	1

Table A.2 Comparison between CVC and IVC Funds

	IVC	*CVC*	*Difference*	*t-statistics*
IPO	0.32	0.34	−0.02	−1.52*
Investment amount	25.35	51.20	−25.85	−12.73***
Duration	1614.04	1916.59	−302.55	−8.24***
Investment rounds	3.91	5.23	−1.32	−14.31***
Syndicate size	4.58	8.94	−4.35	−30.00***
VC fund size	222.97	209.17	13.79	1.32
VC fund age	7.98	8.25	−0.27	−1.73**
IVC fund age	6.93	7.99	−1.06	−5.44***
Later exit stage	0.78	0.89	−0.11	−9.57***
Early invest stage	0.68	0.82	−0.14	−10.45***
Industry 73	0.45	0.53	−0.08	−4.92***

$***$, $**$ and $*$ denote statistical significance at 1%, 5% and 10% level.

Table A.3 CVC vs IVC Funds: Investment Amount per Start-up per Round

Invest.	**R1**	**R2**	**R 3**	**R4**	**R5**	**R6**	**R7**	**R8**
Gr. 0	5.54	6.80	7.76	7.39	7.07	6.34	4.65	5.25
Gr. 1	**9.68**	12.28	10.89	10.67	10.49	7.00	5.28	5.15
Gr. 2	5.31	**17.13**	12.12	14.34	10.95	10.47	7.34	9.93
Gr. 3	4.45	9.43	**19.67**	14.44	13.18	12.37	9.49	7.13
Gr. 4	2.98	7.16	10.63	**19.10**	14.58	11.10	17.61	9.17
Gr. 5	3.14	5.82	9.00	10.65	**16.70**	10.87	9.45	4.85
Gr. 6	3.53	5.31	5.50	4.73	9.51	**22.85**	15.45	11.43
Gr. 7	2.39	4.26	4.74	5.54	5.45	11.02	**14.93**	20.89
Gr. 8	2.68	3.23	3.39	5.82	6.36	5.35	16.53	**20.48**

Table A.4 Investment and Duration Strategies

	Panel A DV: ln(Investment Amount)			Panel B DV: Duration (Days)		
	Model 1	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
CVC	0.176***	0.162***		1.105**	1.085**	
	(5.03)	(4.66)		(2.39)	(1.96)	
CVC_per			0.182***			1.232***
			(3.56)			(3.40)
Investment Rounds	0.105***	0.105***	0.106***	0.853***	0.852***	0.855***
	(18.57)	(18.75)	(18.70)	(−21.54)	(−21.73)	(−21.12)
Syndicate Size	0.133***	0.133***	0.136***	0.974***	0.975***	0.972***
	(32.35)	(32.64)	(33.32)	(−5.41)	(−5.20)	(−5.78)
Syndicate Leader CVC	0.277***	0.270***	0.279***	0.959	0.956	0.90
	(3.42)	(3.35)	(3.32)	(−0.43)	(−0.46)	(−1.05)
ln(VC Fund Size)	0.361***	0.362***	0.361***	1.177***	1.181***	1.178***
	(32.27)	(32.58)	(32.21)	(11.7)	(11.96)	(11.73)
VC Fund Age	0.014***		0.014***	1.02***		1.02***
	(5.63)		(5.56)	(6.62)		(6.66)
IVC Fund Age		0.015***			1.018***	
		(7.21)			(7.00)	
CVC Strategic Re.	0.041	0.039	0.076	1.027	1.017	1.019
	(0.6)	(0.57)	(1.10)	(0.33)	(0.21)	(0.24)
ln(Industry MB)	0.036*	0.038**	0.037**	1.061**	1.072***	1.061**
	(1.92)	(2.06)	(1.97)	(2.23)	(2.62)	(2.24)
Early Invest Stage	−0.011	−0.018	−0.010	1.108***	1.096***	1.107***
	(−0.36)	(−0.60)	(−0.32)	(2.94)	(2.63)	(2.90)
Industry 73	−0.22***	−0.222***	−0.219***	1.167***	1.154***	1.163***
	(−7.16)	(−7.29)	(−7.13)	(4.05)	(3.77)	(3.96)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	4473	4506	4473	4473	4506	4473
Adj. R^2	0.64	0.64	0.64	N/A	N/A	N/A

The t-statistics (for Panel A) and the Z-values (for Panel B) are reported in parentheses.
$***$, $**$ and $*$ denote statistical significance at 1%, 5% and 10% level.

Table A.5 Exit Strategy

	Dependent Variable: IPO						
	Model 1 *LOGIT*	*Model 2* *LOGIT*	*Model 3* *LOGIT*	*Model 4* *LOGIT*	*Model 5* *LOGIT*	*Model 6* *LOGIT*	*Model 7* *OLS*
CVC	0.436*** (4.39)		−0.007 (−0.06)	−0.01 (−0.10)	−0.002 (−0.02)		−0.006 (−0.38)
CVC_per						−0.14 (−0.86)	
ln(Duration)		−0.123** (−1.99)	−0.122** (−1.98)		−0.121** (−1.97)	−0.122** (−1.98)	−0.027*** (−3.15)
Duration Year				−0.098** (−.2.41)			
(Duration Year)^2				0.006** (2.31)			
ln(Investment amount)		0.594*** (13.72)	0.595*** (13.15)	0.594*** (13.14)	0.594*** (13.15)	0.602*** (13.55)	0.079*** (13.90)
ln(VC Fund Size)	0.225*** (5.89)	0.001 (0.02)	0.001 (0.02)	0.009 (0.2)	−0.002 (−0.05)	−0.002 (−0.05)	−0.005 (−0.93)
VC Fund Age	0.026*** (3.09)	0.015* (1.73)		0.015* (1.73)		0.015* (1.69)	0.001 (1.05)
IVC Fund Age					0.01 (1.37)		
Syndicate Leader CVC	0.215 (0.89)	0.31 (1.29)	0.314 (1.26)	0.325 (1.31)	0.29 (1.16)	0.394 (1.51)	0.056 (1.56)
CVC Strategic Re.	0.293 (1.45)	0.241 (1.22)	0.245 (1.19)	0.246 (1.20)	0.24 (1.18)	0.287 (1.40)	0.041 (1.35)
ln(3-month MSCI)	2.23*** (2.83)	2.41*** (2.94)	2.41*** (2.94)	2.33*** (2.84)	2.46*** (3.02)	2.41*** (2.94)	0.272*** (2.87)
ln(Industry MB)	0.135* (1.67)	0.099 (1.18)	0.099 (1.19)	0.105 (1.26)	0.106 (1.28)	0.102 (1.22)	0.019* (1.85)
Later Exit stage	0.822*** (7.10)	0.466*** (3.68)	0.466*** (3.68)	0.46*** (3.63)	0.464*** (3.68)	0.465*** (3.67)	0.048*** (3.04)
Industry 73	−0.727*** (−7.35)	−0.584*** (−5.68)	−0.583*** (−5.67)	−0.58*** (−5.63)	−0.568*** (−5.54)	−0.577*** (−5.60)	−0.088*** (−6.10)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4363	4363	4363	4363	4394	4363	4363
Adj./Pseudo R^2	0.29	0.33	0.33	0.33	0.33	0.33	0.35

The t-statistics and the Z-values are reported in parentheses.
$***$, $**$ and $*$ denote statistical significance at 1%, 5% and 10% level.

Table A.6 Exit Strategy - Instrumental Variable Approach

	Dependent Variable: IPO			
	Model 3	*Model 4*	*Model 5*	*Model 6*
	IV	*IV*	*IV*	*IV*
CVC	−0.077	−0.074	−0.072	
	(−1.35)	(−1.31)	(−1.26)	
CVC_per				−0.135
				(−1.37)
ln(Duration)	-0.024^{***}		-0.024^{***}	-0.026^{***}
	(−2.60)		(−2.57)	(−2.88)
Duration Year		-0.02^{***}		
		(−3.24)		
(Duration Year)^2		0.001^{***}		
		(2.90)		
ln(Investment amount)	0.085^{***}	0.085^{***}	0.084^{***}	0.084^{***}
	(9.97)	(9.97)	(10.02)	(10.38)
ln(VC Fund Size)	−0.007	−0.006	−0.007	−0.007
	(−1.33)	(−1.12)	(−1.34)	(−1.33)
VC Fund Age	0.001	0.001		0.001
	(0.93)	(1.07)		(0.91)
IVC Fund Age			0.001	
			(0.95)	
Syndicate Leader CVC	0.099^{**}	0.099^{**}	0.095^{**}	0.135^{*}
	(2.06)	(2.05)	(1.96)	(1.95)
CVC Strategic Re.	0.084^{*}	0.083^{*}	0.083^{*}	0.087^{*}
	(1.89)	(1.87)	(1.86)	(1.90)
ln(3-month MSCI)	0.282^{***}	0.274^{***}	0.286^{***}	0.275^{***}
	(3.35)	(3.25)	(3.39)	(3.26)
ln(Industry MB)	0.019^{*}	0.019^{*}	0.019^{*}	0.019^{*}
	(1.85)	(1.84)	(1.86)	(1.84)
Later Exit stage	0.047^{***}	0.047^{***}	0.047^{***}	0.046^{***}
	(3.30)	(3.29)	(3.32)	(3.19)
Industry 73	-0.08^{***}	-0.079^{***}	-0.078^{***}	-0.078^{***}
	(−5.14)	(−5.06)	(−5.01)	(−4.98)
Year Fixed Effects	Yes	Yes	Yes	Yes
Robust F-statistics	184.99	184.60	187.53	122.50
Sargan $\chi^2(1)$ statistics	0.758	0.633	0.798	0.702
N	4445	4445	4478	4445
R^2	0.38	0.38	0.38	0.38

Heteroskedasticity-robust t-statistics are reported in parentheses.
$***$, $**$ and $*$ denote statistical significance at 1%, 5% and 10% level.

Table A.7 Rate of Successful Exits

	Dependent Variable: Failure rate	
	Model 1	*Model 2*
	LOGIT	*LOGIT*
CVC	0.0016	
	(0.03)	
CVC_per		0.11
		(0.84)
ln(Duration)	−0.0186	−0.0175
	(−0.56)	(−0.52)
ln(Investment Amount)	−0.0114	−0.0144
	(−0.45)	(−0.59)
Syndicate Leader CVC	0.0224	0.0047
	(0.16)	(0.03)
ln(VC Fund Size)	0.0038	0.0051
	(0.16)	(0.21)
CVC Strategic Re.	0.1674	0.1198
	(0.42)	(0.30)
Later Exit Stage	0.086	0.085
	(1.18)	(1.17)
Industry 73	−0.165	−0.17
	(−0.15)	(−0.16)
Year Fixed Effects	No	No
Industry Fixed Effects	Yes	Yes
N	9032	9032
Pseudo R^2	0.005	0.005

The Z-values are reported in parentheses.
$***$, $**$ and $*$ denote statistical significance at 1%, 5% and 10% level.

Table A.8 Investment and Duration Strategyies for IPO-exit and for Acquisition-exit Start-ups

	DV: ln(Investment Amount)		DV: Duration (Days)	
	IPO	*Acquisition*	*IPO*	*Acquisition*
CVC	0.134**	0.163***	1.089	1.146***
	(2.09)	(4.03)	(1.15)	(2.66)
Investment Rounds	0.145***	0.091***	0.886***	0.832***
	(13.87)	(14.08)	(−9.51)	(−19.93)
Syndicate Size	0.100***	0.149***	0.981**	0.965***
	(15.15)	(28.39)	(−2.55)	(−5.35)
Syndicate Leader CVC	0.361***	0.137	0.994	0.921
	(2.73)	(1.37)	(−0.04)	(−0.64)
ln(VC Fund Size)	0.303***	0.363***	1.248***	1.056***
	(13.98)	(28.88)	(8.06)	(8.91)
VC Fund Age	0.011**	0.013***	1.016**	1.025***
	(2.04)	(4.85)	(2.49)	(6.89)
CVC Strategic Re.	−0.132	0.086	1.171	0.945
	(−1.10)	(1.05)	(1.14)	(−0.55)
ln(Industry MB)	0.011	0.058***	1.038	1.062*
	(0.24)	(2.88)	(0.62)	(1.91)
Early Invest Stage	0.077	−0.023	0.867**	1.277***
	(1.45)	(−0.67)	(−2.36)	(5.60)
Industry 73	−0.227***	−0.172***	1.117*	1.202***
	(−4.06)	(−4.82)	(1.67)	(3.78)
Year Fixed Effects	Yes	Yes	Yes	Yes
N	1444	3029	1444	3029
Adj. R^2	0.70	0.63	N/A	N/A

The t-statistics and the Z-values are reported in parentheses.
$***$, $**$ and $*$ denote statistical significance at 1%, 5% and 10% level.

Table A.9 Panel A Investment and Duration Strategies - IVC v.s. Early CVC Financing

	ln(Investment Amount)		Duration (Days)	
	Model 1	*Model 3*	*Model 1*	*Model 3*
CVC	0.135***		1.222***	
	(2.98)		(3.80)	
CVC_per		0.162***		1.343***
		(2.72)		(4.27)
Investment Rounds	0.104***	0.105***	0.861***	0.862***
	(16.56)	(16.56)	(−18.87)	(−18.63)
Syndicate Size	0.149***	0.149***	0.969***	0.968***
	(31.25)	(31.60)	(−5.72)	(−5.81)
Syndicate Leader CVC	0.198**	0.183*	0.877	0.829
	(2.05)	(1.83)	(−1.17)	(−1.63)
ln(VC Fund Size)	0.376***	0.375***	1.166***	1.166***
	(31.13)	(31.12)	(10.58)	(10.59)
VC Fund Age	0.014***	0.014***	1.021***	1.021***
	(5.09)	(5.05)	(6.44)	(6.42)
CVC Strategic Re.	0.09	0.106	1.000	1.005
	(0.88)	(1.04)	(0.00)	(0.04)
ln(Industry MB)	0.035*	0.035*	1.083***	1.084***
	(1.68)	(1.69)	(2.90)	(2.94)
Early Invest Stage	−0.034	−0.035	1.125***	1.122***
	(−1.07)	(−1.09)	(3.22)	(3.15)
Industry 73	−0.232***	−0.232***	1.153**	1.151**
	(−6.79)	(−6.80)	(3.50)	(3.47)
Year Fixed Effects	Yes	Yes	Yes	Yes
N	3857	3857	3857	3857
Adj. R^2	0.61	0.61	N/A	N/A

The t-statistics and the Z-values are reported in parentheses.
$***$, $**$ and $*$ denote statistical significance at 1%, 5% and 10% level.

Table A.9 Panel B Exit Strategy - IVC v.s. Early CVC Financing

	Dependent Variable: IPO				
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
	LOGIT	*LOGIT*	*LOGIT*	*LOGIT*	*LOGIT*
CVC	0.336**		−0.051	−0.055	
	(2.54)		(−0.37)	(−0.39)	
CVC_per					−0.17
					(−0.9)
ln(Duration)		−0.135**	−0.136**		−0.137**
		(−2.09)	(−2.09)		(−2.12)
Duration Year				−0.108**	
				(−2.49)	
(Duration Year)^2				0.007**	
				(2.3)	
ln(Investment Amount)		0.561***	0.565***	0.565***	0.569***
		(12.22)	(12.01)	(12.01)	(12.16)
ln(VC Fund Size)	0.226***	0.005	0.003	0.01	0.001
	(5.57)	(0.10)	(0.07)	(0.21)	(0.03)
VC Fund Age	0.024***	0.012	0.012	0.013	0.012
	(2.76)	(1.31)	(1.29)	(1.36)	(1.27)
Syndicate Leader CVC	0.045	0.141	0.177	0.189	0.259
	(0.15)	(0.50)	(0.59)	(0.63)	(0.83)
CVC Strategic Re.	0.362	0.307	0.342	0.338	0.384
	(1.26)	(1.11)	(1.16)	(1.15)	(1.32)
ln(3-month MSCI)	2.405***	2.667***	2.67***	2.6***	2.67***
	(2.84)	(3.02)	(3.03)	(2.95)	(3.03)
ln(Industry MB)	0.117	0.075	0.076	0.082	0.078
	(1.37)	(0.85)	(0.87)	(0.93)	(0.88)
Later Exit stage	0.814***	0.481***	0.48***	0.474***	0.479***
	(6.81)	(3.70)	(3.7)	(3.65)	(3.68)
Industry 73	−0.719***	−0.571***	−0.569***	−0.565***	−0.565***
	(−6.69)	(−5.12)	(−5.09)	(−5.06)	(−5.05)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	3749	3749	3749	3749	3749
Adj./Pseudo R^2	0.30	0.33	0.33	0.33	0.33

The Z-values are reported in parentheses.
∗ ∗ ∗, ∗∗ and ∗ denote statistical significance at 1%, 5% and 10% level.

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